“CAPABILITY GAPS IN USMC MEDIUM LIFT”

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Introduction

Currently, the Marine Corps is in the process of fielding two new rotary-wing airframes which are touted to replace the venerable CH-46E. Both the MV-22 and UH-1Y airframes offer a tremendous increase in capabilities for the Marine Corps in several different flight regimes, but with the increases also come a major hole in abilities for the MAGTFs regarding medium lift capabilities. The CH-46E is an old airframe and needs to be replaced. The current options will bring new capabilities but will not fill the capability gap between light utility aircraft and heavy lift aircraft. The Marine Corps must field an additional medium lift platform because a significant capabilities gap will exist between the UH-1Y, the MV-22, and what is currently available with the CH-46E with its small downwash signature, rapid loading and unloading of cargo, and ability to fit into tight Landing Zones without damaging foreign relations.

Rotor downwash

The first issue is the amount of rotor downwash created by the MV-22. For aircraft to fly, the wind moving across the wing must create a lifting force greater than the gross weight

of the aircraft. In the rotary wing community, this is created by the turning rotors. Newton's Third Law of Motion states that for every action there is an equal but opposite reaction. The reaction to lift is downwash. As max gross weight (MGW) increases, the amount of lift required increases, so a heavier aircraft must produce more lift than a lighter aircraft in order to fly. To produce this lift, the rotor system must move more air which increases the amount of downwash created.

The size of the rotor system comes into effect here as well. The effective size of the rotor system is as simple as calculating the surface area of the rotor. The rotor system of a CH-53E is 79 feet in diameter[1] which gives a surface area of 15,399 square feet. Each rotor in the system of the CH-46E is 51 feet in diameter[2] which gives a surface area of 6,417.7 for a total system of 12,835.4 square feet. Each rotor in the MV-22 rotor system is 38 feet in diameter[3] which gives a surface area of 3,562.9 square feet for a total of 7,125.8 square feet. These numbers show that the rotor system of the MV-22 is 56% of the size of the CH-46E and 46% of the size of the CH-53E. The MGW of the CH-46E is 24,300 pounds,[4] the MV-

[1] NTTP 3-22.5 RWTACSOP. November 2006, pg 133
[2] NTTP 3-22.5 RWTACSOP. November 2006, pg 132
[3] Jack Satterfield. *V-22 Osprey.* Boeing Backgrounder July 2008
[4] NTTP 3-22.5 RWTACSOP. November 2006, pg 132

22 is 60,500 pounds,[5] and the CH-53E is 73,500 pounds.[6] When the MGW of the MV-22 is compared to the MGW of the CH-53E and the CH-46E it is obvious that the rotor downwash of the MV-22 must be concentrated over a much smaller area during flight operations.

The rotor downwash is a measured air pressure. Air pressure in a rotor system can be defined by Boyle's Law which states that the volume of a sample of gas (ambient air in this case) is inversely proportional to its pressure, if temperature remains constant. This can be shown in the mathematical equation of P1V1=P2V2. Whenever the rotor size is decreased (the volume in the above equation) or the weight of the aircraft increases (the pressure in the equation), the downwash produced by the rotor system increases. For flight to be possible, the amount of air displaced must be equal to or greater than the weight of the aircraft which is the air volume flowing through the system. In the case of the MV-22, the rotor size has decreased significantly compared to both the CH-46E and CH-53E, and the weight has increased compared to the CH-46E. This increases the load on the rotor disc.

Rotor disc loading is an important characteristic for the aerodynamic aspect of the rotor system. As the rotor disc

[5] NTTP 3-22.5 RWTACSOP. November 2006, pg 143
[6] NTTP 3-22.5 RWTACSOP. November 2006, pg 133

loading increases, the dynamic stress on the system increases. As the dynamic stress increases, one of the byproducts is an increase in concentration and speed of the rotor downwash. When the MGW is compared to the surface area of each aircraft (which is called rotor disc loading) the CH-46E has a disc load of 1.9 pounds per square foot (psf), the CH-53E has a disc load of 4.77 psf, while the MV-22 has a disc load of 8.49 psf. The ratio of MGW to rotor system area for the MV-22 is almost twice that of the CH-53E and over four times the CH-46E.

The smaller rotor system size and increased weight of the aircraft increases the amount of downwash produced which increases the hazards of blowing debris in a landing zone (LZ). For example, during relief efforts in Indonesia after the tsunami in 2005 most of the LZs used by HMM-262 were completely surrounded by shanty type structures. The villages receiving aid were only able to get supplies by helicopter. If CH-46E aircraft had not been available, the victims of the tsunami would not have received needed supplies and thousands of additional lives would have been lost. If the MV-22 had already replaced the CH-46E in HMM-262, aircrew would not have been able to land in those zones and deliver the required aid because of the effects of their downwash on the surrounding structures. Being able to deliver supplies and relief without

negatively impacting the infrastructure by blowing over the few remaining structures is one of the main reasons the CH-46E defines medium lift helicopters.

One argument used for the MV-22 not being classified as a medium lift aircraft is that the Federal Aviation Administration (FAA) defines large aircraft as 41,000 pounds or heavier and small as 41,000 or less maximum certificated takeoff weight.[7] The reason the FAA makes this distinction is based on downwash and its effects on the surrounding environment. They do not distinguish between fixed wing and rotary wing aircraft for weight. As any pilot learns from the first day of flight school, when a smaller aircraft takes off behind a larger aircraft, consideration must be given to wake turbulence. Wake turbulence is equally important whether talking of rotary wing operations in austere environments or commercial airlines operating at an established airport. The effects of wake turbulence and rotor down wash affect the surrounding environment. Just as commercial airports must take into consideration the wake turbulence and construct barriers to keep from affecting the surrounding environment, wake turbulence must be taken into account when sending an aircraft into a country for humanitarian response. If units

[7] Federal Aviation Regulations/Aeronautical Information Manual 2006. Aviation Supplies & Academics, Inc. Newcastle, WA. pg 908

are sent into a community to relieve suffering, but only succeed in blowing over the remaining structures, irreparable damage has been done to foreign relations.

Capabilities lost

The MV-22 is touted as a replacement for the CH046E and will tie in with the capabilities of the UH-1Y when it comes on-line. The gap created between what the MV-22 can do and what the CH-46E was designed for comes at the lower end of the medium lift requirements established by the United States Marine Corps. The current forecast for USMC assets list the UH-1Y as bridging the gap between light utility and the MV-22. The UH-1Y will have a significant increase of capabilities over the preceding UH-1N but still lacks for medium lift in cargo handling capabilities. The UH-1Y does not have a rear loading cargo ramp. With the size of the interior cabin, a standard cargo pallet will not fit. The primary advantage the CH-46E has over most other helicopters is that it can load and unload cargo rapidly. With the rear rotor clearance of almost seventeen feet, most standard forklifts can maneuver in and out of the CH-46E rotor arc during operation. With the UH-1Y, the rotor clearance can drop to as low as five feet which requires aircrew to hand-load all cargo. The ramp and cargo

winch inherent in the CH-46E gives a significant advantage in terms of loading speed. The ramp with good rotor clearance allows easy maneuvering of support vehicles.

Case Study

During Operation Enduring Freedom, a British unit took casualties in the middle of an unmarked mine field. The only asset they could task in the time-critical realm of Casualty Evacuation (CASEVAC) was a CH-47. When the CH-47 came in to try and extract the casualties, the rotor down-wash was significant enough to dislodge debris with such force that it set off several surrounding mines. This in turn caused more injuries and led to the initial victim dying en-route to the medical facility of wounds received. In debrief, one of the main points was that medium lift assets are required for CASEVAC missions because of the reduced rotor wash[8]. The advantages the CH-46E affords during CASEVAC missions are the internal cargo winch which would allow casualties to be hoisted into the aircraft from a hover in an emergency situation like this, the quick loading of casualties and medical personnel using the cargo ramp, and the reduced downwash compared to the MV-22 or the CH-53E.

[8] Giovanni de Briganti. *Eurowatch.* Rotor & Wing, December 2008.

Recommendations

In the current operating environment of Operation Iraqi Freedom and Operation Enduring Freedom, most military procurement committees are looking for off-the-shelf products to fill shortfalls in current inventories. Several aircraft manufacturing companies have combat-proven airframes ready to fill the upcoming gap in Marine Corps rotary-wing aircraft. Augusta-Westland has the EH-101, which has already been selected as the replacement for the H-3 for presidential transport and re-designated the VH-71. Also, Sikorsky has the H-92 which was included in the bid for the combat search and rescue (CSAR) replacement for the United States Air Force. Both of these options have all the capabilities, to include a cargo ramp and smaller downwash signature, which are being lost in the new inventory of USMC helicopters. The VH-71 is currently being tested at Patuxent River Naval Air Station and has met great success as the replacement based on its flight characteristics[9]. Several NATO countries and various private companies for VIP transport have operated the H-92. Both airframes have been used with great success in combat environments. The VH-71 and H-92 are just two of several

[9] *Presidential Helicopter Completes First Flight.* Rotor & Wing. December 2008

options available for service with minimal flight testing required for induction into Marine Aviation.

The off-the-shelf options available should be considered as supplements to the inventory as it will look once the CH-46E is phased out. The standard Marine Expeditionary Unit Aviation Combat Element (MEU ACE) currently deploys with 12 CH-46E, 4 CH-53E, 3 UH-1N, and 4 AH-1W aircraft. The wave of the future will be 10 MV-22, 4 CH-53E, 3 UH-1Y, and 4 AH-1Z aircraft. The MEU ACE could easily be augmented with an additional detachment of medium lift aircraft to complete the requirement the MEU has for its ACE. This would allow for successful completion of all the required Mission Essential Skills a MEU, by United States Marine Corps doctrine, must be able to execute for the coveted Special Operations Capable (SOC) rating. Currently, the Department of Defense tasking requires 3 MEU(SOC) units to be deployed at any given time. Once the MV-22 becomes the “medium-lift” asset for the MEU, the SOC rating will be impossible to achieve. This is going to either require an additional aircraft or for the SOC qualifications to change.

Conclusion

The forecasted inventories for Marine Aviation, create several gaps in capabilities. The foremost gap will be in

Medium Lift; which cannot be ignored, but can easily be corrected by augmenting with an actual medium lift platform. The current task-organization of the Marine Aircraft Wings (MAWs) usually have a Marine Heavy Helicopter Squadron (HMH) and Marine Light Attack Helicopter Squadron (HMLA) that are tasked with providing Detachments (Dets) to the MEUs they have been tasked to support. The easiest solution would be to stand-up a Marine Medium Helicopter Squadron (HMM) for each MAW that can train and organize to be ready to support any MAGTF with Dets of Medium Lift aircraft to fill the gaps in coverage. This would allow for a more robust ACE package with the capabilities to provide support in any mission and provide the support that will mean life or death to the Ground Combat Element being supported.

Word Count: 1992

Bibliography

Commander, Naval Strike and Air Warfare Center. *NTTP 3-22.5 RWTACSOP.* Yuma, Arizona: MAWTS-1, November 2006.
de Briganti, Giovanni. "Eurowatch." *Rotor & Wing*, December 2008: 62.
Federal Aviation Regulations/Aeronautical Information Manual. Newcastle, WA: Aviation Supplies & Academics, Inc., 2006.
Satterfield, Jack. *V-22 Osprey.* Boeing Backgrounder, July 2008.